WORLD BEST PRACTICE FOR THE DEVELOPMENT AND USE OF UAV EQUIPMENT IN CITIES

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Abstract: The growth of the population is the primary trend that affects urban concepts. Technologies that cities develop on the basis of stakeholder cooperation (businesses, ministries, citizens' communities) serve to prevent the collapse of natural and social systems. Current and very trendy is the technology of drones, which simplify and improve urban processes in various implementation areas. The main motive for writing the article was to identify best practices for the development and use of UAVs in cities in Europe, the United Kingdom, the Americas, the East and Australia. The article used methods of secondary analysis, case studies, summarization and comparison. Each surveyed city prefers a different framework depending on the geographical area, the natural and competitive advantage determines the preferred area for the implementation of UAVs. In large technology cities such as Singapore, Los Angeles and Hamburg, the primary area of drones is transportation, in Kansas, agriculture. The basic finding of the article is that each city is specific, the application of new technologies should reflect global trends, but also local conditions.

Keywords: unmanned aerial vehicle (UAV), cities, application areas, IoT

JEL Classification: M15, O32

1. INTRODUCTION

In 2050, the global trend of urbanization is to increase the size of the population in cities to 90%. The size of the population negatively affects the consumption of limited resources and the complex state of the holistic system, which may collapse due to the lack of necessary resources [1]. Smart City concepts therefore need to be built through an intelligent technology core, the primary technology of which is the Internet of Things (IoT). According to Airborne Drones Smart City, [1] represents:

- sensor system,
- cooperation, participation and feedback between all stakeholders of the city,
- efficient and reliable technological infrastructure,
- a platform for urban innovation,
- management and decision-making on the principle of Big data processing,
- whether meeting social, economic and environmental needs.

Effective city management and the use of technology contribute to an increased quality of life for residents, reduced consumption of limited resources and the achievement of sustainability. Drones are an evolving trend that can generate implementation benefits for various Smart City application areas. According to Alsamhi et al. UAV devices can reduce up to 56% of energy consumption. The interdependence between the Internet of Things (IoT) and drones is particularly evident in data sharing. Smart drones are characterized by simple use, dynamic adaptation, the ability to obtain data from difficult-to-access terrains in real time at low cost. Intelligent software not only monitors the obtained data, but above all analyzes, compares, transforms into the form of information and uses it in the management of Smart City concepts [2 - 6]. In addition to IoT technology, UAV devices also use information and communication technologies, RFID technology and a 5G network. Smart City Amsterdam connects UAVs with IoT and ICT, including RFID in improving quality of life, London in managing limited resources and efficient waste management [2].

The topic of drones in the Smart City concept is a trend of the future. According to a research study by International Data Corporation, $ 80 billion was invested in smart drones in cities in 2016 and $ 135 billion in 2021, an increase of 69% [4]. Collaboration between the Internet and technologies such as IoT and drones can have a positive impact on the following Smart City areas [1 - 6]:

- fire detection,
- transport,
- monitoring of environmental pollution,
- parking,
- traffic accident reporting,
- stabilize urban security,
- anticipate climate change,
- increase the quality of health services,
- geodetic works and mapping,
- deliveries of goods,
- crowd management,
- agriculture,
- improving the quality of life,
- real-time data collection,
- reducing energy consumption,
- animal monitoring, etc.

2. METHODOLOGY

The main motive for writing the article was to identify best practices for the development and use of UAVs in cities in Europe, the United Kingdom, the Americas, the East and Australia. Within the article, the method of secondary

analysis of professional literature in Chapter 1 was used. The results (Chapter 3) were analyzed and summarized through case studies, which were selected in terms of:

— the geographical layout of the cities so that all areas are covered, i. e. Europe, the United Kingdom, the Americas, the East and Australia,

— time criterion, i. e. case studies, articles and surveys must not be older than 2016 inclusive,

— the thematic focus was to reflect the development and use of UAV facilities in cities.

In the last Chapter 4, the method of summarizing and comparing common and different elements, used according to the analysis of case studies, was used.

3. RESULTS

Based on the results from Unmanned Airspace, GovTechBiz, Manning and Reznik, the following list of best practices of sites that use UAVs was selected in Table 1.

Europe

Cities in the geographical area of Europe cooperate within the so-called UAM, i. e. Urban air mobility [7]. Brussels and Ghent are cooperating in the development of drones in healthcare, for example in the form of application prototypes of unmanned ambulances. The test center is located in St Truiden [7].

The Bulgarian city of Plovdiv uses drones for traffic management, safety, efficient provision of medical services or fast delivery of consumer goods. In addition to UAM concepts and advanced technology, UAV devices are also supported by the Ministry of Transport and the Department of Information and Communication Technologies and the Aeronautical Research Institute focusing on space technologies [7].

German cities such as Hamburg and Ingolstadt are developing drones that support the maintenance of port bridges and industrial turbines. In addition to industry, the projects are also supported by universities and aviation institutions, such as Airbus and Lufthansa, including the Audi car group [7].

In Warsaw there is a radar portal called DroneRADAR, which manages up to 40,000 flights in 1 year [7].

Berne applies drones to the postal services sector. Within the medical environment, small packages or blood samples are transported by UAVs between the hospital and 56,000 inhabitants. The delivery network of packages from online sales also operates in Zurich, this service and technology are implemented by companies such as Daimler. Mercedes, Matternet and Siroop implemented test flights as early as 2017 [7].

Great Britain

Bradford, London, Preston and Southampton are managed and controlled by NESTA Flying High. Drone testing is carried out in numerous rural areas with low population density [7]. UAVs are used in the UK in [7]:

— agriculture,

— healthcare,

— security,

— environmental protection,

— flood management.

America

The city of Ensenada uses drones to support policing and stabilize order and security. The new technology has reduced the number of thefts by 30% and crime by 10% over a period of 6 months [7].

UAVs in Boston may operate commercially with a license from the Federal Aviation Administration (FAA) [7].

US cities, including Oklahoma, are participating in the UAS IPP project, i. e. integration of drones. Radars on drones streamline operation at night and during the day, predict weather conditions and monitor visibility in the field [7].

Dallas and Los Angeles plan to implement UAV taxis in transportation by 2023. Research and initial prototype designs have continued since 2018 [7].

In San Diego, drones deliver packages and monitor border crossings, helping to create a safe city environment. The aim of the new forms of UAV based on the 5G network is to communicate and obtain information from autonomous vehicles and to build the interoperability of Smart City [7].

City of Reno focuses on the drone delivery of medical equipment and supplies, such as defibrillators or weather monitoring [7, 8].

Table 1 List of best practices of sites within the use of UAVs

	Area			
	Europe	**Great Britain**	**America**	**East and Australia**
City	Brussels	Bradford	Ensenada	Shanghai
	Gent	London	Boston	Chiba City
	St Truiden	Preston	Oklahoma	Kanagawa
	Plovdiv	Southampton	Dallas	Canterbury
	Hamburg		City of San Diego	Queenstown
	Ingolstadt		City of Reno	Singapore
	Varsaw		Kansas	Dubai
	Berne		Lee County	
	Lugano		North Carolina	
	Zurich		North Dakota	
			San Francisco	
			Raleigh	
			Las Vegas	
			Albuquerque	
			San Jose	

The Kansas Department of Transportation prefers UAV use in rural agriculture, based on sensors, optical networks, and current satellites [7, 8].

Lee County primarily uses drones in the form of satellite communications or mosquito protection, which are widely reproduced in the geographical area [8].

North Carolina prefers UAV technology to support small and medium-sized businesses in the application area of customer distribution.

North Dakota uses drone data to support management and decision-making for aerospace systems, training and associated processes [8].

San Francisco has a drone support community of up to 2,000 members. UAV equipment and their management is not only a popular work activity, but also a leisure activity. The city of San Jose has the same group of enthusiasts, supporting the development of new technologies in Silicon Valley, for example. Drones and their understanding create the so-called drone culture, which is reinforced by the annual exhibitions of these drones [9].

A military base in Las Vegas uses drones in the desert area. The city also applies drones to business activities or invests in the development of future UAV taxis [9].

Tourist destination Rio Grande is located in the city of Albaquerque, which uses drones in photos and videos of this natural site. In addition, UAVs mediate city security by monitoring borders and monitoring the smuggling of illegal goods from Mexico to America [9].

East and Australia

Shanghai residents obtain food through drone distribution from Alibaba from 100 different restaurants [7].

Chiba City in Japan controls its airspace through drones. Kanagawa Prefecture, in collaboration with the private sector, has developed a network to control several drones that operate independently on a 4G network. Since March 2017, drones have also been used in the Fukushima area of Minamisoma [7].

The New Zealand airline is participating in drone projects and testing with Zephyr Airworks. The main goal of the project is to develop and implement a Cora flying taxi for the Canterbury and Queenstown area [7].

The Ministry of Transport and the Civil Aviation Authority in Singapore are working together to create a prototype autonomous aircraft, the successful first flight of which took place in 2017 at a local university. Cape in Jordan also wants to create drones as separate aircraft. [7]

Dubai prefers drone taxi services and air force. The city has created a detailed database on UAV facilities, which contains information on location, flight duration, altitude, direction, speed or deviation from the flight path [7].

4. DISCUSSIONS AND CONCLUSIONS

The following Table 2 summarizes the common and different elements of UAV use in selected areas of Europe, the United Kingdom, the Americas, the Far East and Australia. The common elements are represented by a cross.

Chapter 3 and Table 2 resulted in a single common element of test centers. In Europe, the United Kingdom and the United States, the common elements are the use of drones for health and safety. The United Kingdom and America prefer drones for agricultural activities in their cities. US, Australian and Eastern and European cities support the business sector by drone deliveries directly to customers' homes, including transportation solutions such as UAVs.

The use of UAV technology in cities brings strategic management the opportunity to effectively improve and simplify processes in various application areas. The best practices for the development and use of drones are cities from geographical areas of Europe (10 cities), the United Kingdom (4 cities), the Americas (15 cities), the East and Australia (7 cities). Each area prefers a different drone control framework and has testing centers (universities, military bases, businesses, etc.). The preference for a particular application area depends on the natural conditions of the city, for example, the rural area of Kansas in America prefers agriculture. The most preferred areas for the implementation of UAV facilities in the urban concept in general, based on the findings of the article, are:
− transport and healthcare,
− security and distribution.

Table 2 Common and different elements of drone use according to geographical area

Element	Area			
	Europe	Great Britain	America	East and Australia
UAM framework	x			
Healthcare	x	x	x	
Test centers	x	x	x	x
Transport	x		x	x
Security	x	x	x	
Distribution	x		x	x
Maintenance	x			
NESTA Flying High		x		
Agriculture		x	x	
Environmental protection		x		
Flood management		x		
Tourism			x	
UAS IPP			x	

Source: own processing according to [7 - 9]

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